

High Temperature Processing of Fish Sausage-II. Effect of Certain Preservatives on the Shelf Life

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The effects of preservatives like fat coated sorbic acid (FCSA) and glucono-delta-lactone (D-lactone), both separately and in combination, on the shelf life of high temperature (115.6°C for 20 min) processed fish sausage, stored at three different temperatures namely, ambient ($28 \pm 2^{\circ}\text{C}$), cooler storage ($2 \pm 2^{\circ}\text{C}$) and refrigerator ($10 \pm 2^{\circ}\text{C}$) were studied. Whereas the control (without preservative), FCSA, D-lactone and FCSA + D-lactone treated samples could be stored for 9, 9, 11 and 13 days respectively at ambient temperature, those stored at lower temperatures were found to be in acceptable condition for 70, 70, and 80 days respectively. Organoleptic evaluation of taste, flavour the products carried out by panelists revealed that FCSA and FCSA + D-lactone treated samples were unacceptable with regard to the taste, flavour and texture. However, the taste flavour and texture of the control and D-lactone treated samples were in acceptable condition.

Fish sausage being a readily perishable product at ordinary temperature, needs to be preserved by the incorporation of preservatives. The addition of preservatives to fish sausage is not only effective in preventing the growth of bacteria which survive the processing, but also effective in reducing the thermotolerance of the bacteria present in raw meat during processing (Tanikawa, 1971). In India, though the method of preparation of fish sausage is well known since 1962, the problem of its preservation at ambient temperature has not been solved so far (Chandrasekhar & Mohite, 1978). Saralaya & Bhandary (1978) have reported that the non-availability of a suitable permitted chemical preservative is one of the major constraints confronted with the large scale manufacture and marketing of fish sausage in India. In view of these facts, investigations were carried out to explore the possibility of using different preservatives to prolong the shelf life of the product. In the present study an attempt has been made to elicit the effect of preservatives like fat

coated sorbic acid (FCSA) and glucono-delta-lactone (D-lactone), both separately and in combination, on the shelf life of high temperature processed fish sausage.

Materials and Methods

Fish sausage was prepared from the meat of *Nemipterus japonicus* together with other ingredients such as starch, sugar, salt, spices and colour solution added in appropriate proportions according to the usual recipe formula (Raj, 1984). Glucono-delta-lactone, a Sigma chemical and FCSA were the two preservatives employed to study their effects in preserving the product. FCSA is a white powder consisting of 33% sorbic acid coated by 67% hardened oil (animal fat). During heating, the coated oil melts allowing the acid to ooze out into the emulsion, lowering its pH and preserving the product simultaneously (Matsuda, personal communication).

The various stages of sausage preparation included meat separation, mincing, grinding, stuffing and sealing. After completion of the grinding or mixing process, the sausage paste was divided into 4 batches to give different chemical treatments as follows:

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- I (control) No preservative was added. The ground fish meat paste alone was stuffed into the casing.
- II The fish meat paste was mixed with 0.6% FCSA.
- III D-lactone at a concentration of 0.5% was added to the fish meat paste.
- IV A combination of 0.6% FCSA and 0.5% D-lactone was mixed with the fish meat paste.

The stuffed sausages were sealed and processed in steam at 115.6°C for 20 min as described by Raj (1984). The products were then stored at different temperatures namely, room temperature ($28 \pm 2^{\circ}\text{C}$), cooler storage ($2 \pm 2^{\circ}\text{C}$) and refrigerator ($10 \pm 2^{\circ}\text{C}$) for assessing their shelflife.

Organoleptic evaluation was carried out to study the product quality and acceptability by a taste panel consisting of six members using a four point scale (A=4, B=3, C=2, D = 1 and E =0). The samples stored at room temperature were drawn weekly.

Results and Discussion

The results of the panel tests conducted to assess the organoleptic quality attributes of the products such as appearance, texture, flavour, taste and colour are presented in Tables 2, 3 and 4.

Shelflife

Table 1 gives the shelflife of the various samples of fish sausage at different storage temperatures. The control, FCSA, D-lactone and VSCA + D-lactone treatments could be kept in good condition for 9, 9, 11 and 13 days respectively at room temperature. The addition of FCSA to fish sausage did not confer additional shelf life over the control. This might be due to the inactivation of sorbic acid contained in the FCSA when fish sausage was processed at a high temperature. However, the D-lactone treated sample extended the shelflife to 11 days. The increase in shelf life might be due to the mild acidity produced in the product which retarded the growth of bacteria in acidic media as observed by Okada & Takesu (1965). The combined addition of FCSA and D-

lactone prolonged the shelflife of the product upto 13 days. This result agrees with the investigations of Uchiyama & Amano (1959) and Okitsu *et al.* (1964) that two or more preservatives jointly used are more effective than the use of a single preservative.

Table 1. Shelflife of various samples of fish sausage at different storage temperature (in days)

Treatments	Room temperature ($28 \pm 2^{\circ}\text{C}$)	Cooler storage ($2 \pm 2^{\circ}\text{C}$)	Refrigerator ($10 \pm 2^{\circ}\text{C}$)
Control	9	70	70
FCSA	9	70	70
D-lactone	11	80	80
FCSA + D-lactone	13	80	80

The results of the organoleptic evaluation of the control sample stored both in the cooler storage and refrigerator indicated that the product remained in acceptable condition upto 70 days. The FCSA treated sample also registered the same shelflife as that of control. However the samples treated with D-lactone and FCSA + D-lactone could be stored for a period of 80 days at the low storage temperature. There was no marked difference observed in the quality and shelf-life of these products.

Spoilage

Sausages stored at the room temperature spoiled mainly due to gas formation (swelling) and discolouration at the sealing point of the casing. Tanikawa (1971) and Yermal *et al.* (1972) have reported that the swelling of the casing is due to the production of gases like ammonia and carbondioxide resulting from the decomposition of protein which is brought about by the highly heat resistant organisms like *Clostridium* sp. and *Bacillus* sp. Similarly, the discolouration observed at the point of sealing is due to *Bacillus* sp. or probably also due to the amino-carbonyl reaction between carbohydrates and amino acids (Mori *et al.* 1974).

Organoleptic attributes

The average scores given for the organoleptic characteristics of the various samples of fish sausage are summarised in Tables 2,

Table 2. *Organoleptic evaluation of fish sausage stored at room temperature ($28 \pm 2^\circ\text{C}$) (average score)*

Control						FCSA					D-lactone					FCSA + D-lactone							
Days	Ap	Te	Fl	Ta	Cl	Days	Ap	Te	Fl	Ta	Cl	Days	Ap	Te	Fl	Ta	Cl	Days	Ap	Te	Fl	Ta	Cl
0	3.8	4.0	3.6	3.6	3.2	0	3.2	3.0	2.8	2.0	3.0	0	4.0	4.0	3.0	3.0	4.0	0	3.0	4.0	2.8	2.8	3.0
3	3.2	3.8	2.5	3.0	3.0	3	2.5	3.0	2.5	2.3	3.0	3	3.6	3.8	2.8	3.2	3.8	3	3.0	3.8	3.0	3.0	3.0
6	3.0	3.8	2.2	2.8	3.0	6	2.3	2.6	2.3	2.0	2.6	6	3.8	3.2	3.0	2.8	3.2	6	3.3	3.3	2.8	3.0	2.8
9	3.0	3.5	2.5	2.2	2.8	9	2.0	2.2	1.8	1.8	2.2	9	3.0	3.0	2.0	2.5	3.5	9	3.0	3.3	2.0	2.0	3.0
	Mean score-3.12						Mean score-2.46					11	2.8	3.0	2.2	2.2	3.2	11	2.8	3.0	2.0	2.0	2.8
													Mean score-3.15					12	3.0	3.0	2.0	2.0	2.8
10	Rejected by panelists due to spoilage of the product					10	Rejected by panelists due to spoilage of the product					12	Rejected by panelists due to spoilage of the product					13	2.8	2.8	1.8	1.8	2.5
																			Mean score - 2.78				
																		14	Rejected by panelists due to spoilage of the product				

Ap = Appearance; Te = Texture; Fl = Flavour; Ta = Taste; Cl = Colour

Note: Maximum possible score for each characteristic = 4.0

Table 3. *Organoleptic evaluation of fish sausage in cooler storage ($2 \pm 2^\circ\text{C}$) (average score)*

Days	Control					FCSA					D-lactone					FCSA - D-lactone				
	Ap	Te	Fl	Ta	Cl	Ap	Te	Fl	Ta	Cl	Ap	Te	Fl	Ta	Cl	Ap	Te	Fl	Ta	Cl
0	3.8	4.0	3.6	3.6	3.2	3.2	3.0	2.8	2.0	3.0	4.0	4.0	3.0	3.0	4.0	3.0	4.0	2.8	2.8	3.0
7	3.5	4.0	3.6	4.0	3.2	3.0	3.0	2.8	2.0	3.2	4.0	4.0	3.2	3.2	4.0	3.6	3.2	3.0	2.8	3.2
14	4.0	4.0	4.0	3.5	3.5	3.6	3.2	2.6	2.0	2.8	3.6	3.3	3.0	3.0	3.8	3.3	3.6	3.0	2.3	3.0
21	3.0	3.3	3.0	3.3	3.6	3.3	3.3	2.6	2.2	3.0	4.0	3.0	2.6	2.6	3.2	3.0	3.6	2.8	2.6	2.8
28	3.0	3.6	3.3	3.0	3.0	3.0	3.0	2.0	1.8	2.8	3.2	3.3	2.8	2.6	3.0	3.0	3.0	2.8	2.3	2.6
35	3.2	3.6	2.8	2.8	3.0	3.2	3.3	1.8	1.6	2.8	3.0	3.6	3.0	2.8	3.2	3.2	3.0	2.6	2.2	3.0
42	3.0	3.2	2.0	2.0	2.8	2.8	3.0	1.3	1.3	2.8	3.0	3.0	2.6	2.0	3.0	2.8	3.2	2.2	2.0	2.8
49	3.0	3.0	2.0	2.2	3.2	2.6	2.8	1.0	1.0	3.0	2.8	3.2	2.0	1.8	2.8	2.8	3.0	2.0	1.8	3.0
56	3.2	3.6	2.0	1.8	3.0	3.0	3.0	1.3	1.0	2.6	3.0	3.0	2.2	1.6	3.0	3.0	2.8	1.8	1.0	2.2
63	2.6	3.0	1.6	1.3	2.6	2.0	2.6	1.0	0	2.2	2.6	2.8	1.8	2.0	2.6	2.2	2.0	1.0	1.0	2.0
70	2.0	3.0	1.0	1.0	2.0	2.0	2.8	0.8	0	2.6	2.8	2.0	1.0	1.0	2.0	2.0	2.0	1.2	1.2	2.2
	Mean score - 2.97					Mean score - 2.37														
77	Rejected by panelists due to poor taste and flavour					Rejected by panelists due to poor taste and flavour					2.0 2.2 1.0 0.8 2.2					2.0 2.2 1.3 1.0 1.8				
80	—					—					2.8 2.6 1.2 1.0 2.6					1.8 1.8 1.0 0.8 2.0				
											Mean score - 2.72					Mean score - 2.43				
											Rejected by panelists					Rejected by panelists due to objectionable odour and taste				

Ap = Appearance; Te = Texture; Fl = Flavour; Ta = Taste; Cl = Colour

Note: Maximum possible score for each characteristic = 4.0

Table 4. *Organoleptic evaluation of fish sausage stored in refrigerator ($10 \pm 2^\circ\text{C}$) (average score)*

Days	Control					FCSA					D-lactone					FCSA + D-lactone				
	Ap	Te	Fl	Ta	Cl	Ap	Te	Fl	Ta	Cl	Ap	Te	Fl	Ta	Cl	Ap	Te	Fl	Ta	Cl
0	3.8	4.0	3.6	3.6	3.2	3.2	3.0	2.8	2.0	3.0	4.0	4.0	3.0	3.0	4.0	3.0	4.0	2.8	2.8	3.0
7	4.0	4.0	4.0	4.0	3.6	3.0	3.2	2.8	2.2	3.2	3.6	4.0	3.0	3.0	4.0	3.6	4.0	2.0	2.3	3.0
14	4.0	4.0	3.8	3.8	3.6	3.3	3.0	3.0	2.6	3.0	3.0	3.2	3.2	3.3	3.0	3.0	3.3	2.8	2.8	3.2
21	3.0	3.6	3.0	3.0	3.6	3.0	3.3	2.6	2.0	3.0	3.6	3.8	3.3	2.8	3.8	3.0	3.0	2.6	2.0	2.8
28	3.0	3.0	3.8	3.2	3.0	2.8	3.0	2.0	2.0	3.2	3.0	3.0	3.0	2.8	3.3	3.3	3.6	2.0	2.6	3.0
35	3.2	3.3	2.0	2.0	3.0	3.2	2.8	2.0	1.8	3.0	3.0	3.6	2.8	3.2	3.0	3.2	3.0	1.8	2.0	2.8
42	3.0	3.0	2.2	2.0	3.2	2.6	2.8	1.8	1.2	2.8	3.2	3.2	3.0	2.6	3.2	2.8	3.2	1.8	1.8	3.2
49	2.8	3.2	2.0	1.8	3.0	2.6	2.6	1.6	1.6	3.2	2.8	3.0	3.2	2.0	2.8	3.2	3.0	2.8	2.4	2.6
56	3.0	3.0	1.8	1.8	2.8	2.0	2.0	1.0	1.0	1.8	2.8	2.6	2.0	2.0	3.2	2.8	2.8	2.0	1.8	2.0
63	2.8	3.0	1.8	1.6	2.6	2.0	2.6	1.0	0.8	2.6	3.0	2.8	1.8	2.2	3.0	3.0	2.0	1.3	1.6	1.8
70	2.0	2.8	1.0	1.0	2.6	1.8	1.8	0	0	2.8	2.0	2.0	1.6	1.8	2.6	2.6	2.2	1.0	1.0	2.0
	<i>Mean score - 2.96</i>					<i>Mean score - 2.35</i>														
77	Rejected by panelists due to poor taste and flavour					Rejected by panelists due to objectionable flavour and taste					2.8	2.6	1.0	1.0	2.0	2.0	1.8	0.8	0.8	2.2
80	—					—					2.6	2.2	1.0	1.0	2.0	1.8	1.6	0	0	1.8
											<i>Mean score - 2.80</i>					<i>Mean score - 2.40</i>				
											Rejected by panelists					Rejected by panelists due to objectionable flavour and taste				

Ap = Appearance; Te = Texture; Fl = Flavour; Ta = Taste; Cl = Colour.
 Note: Maximum possible score for each characteristic = 4.0

Table 5. Analysis of variance on the mean panel scores of different samples of fish sausage

Source of variation	Room temperature (28 ± 2°C)			Cooler storage (2 ± 2°C)			Refrigerator (10 ± 2°C)		
	Degree of freedom	Mean sum of squares	F ratio	Degree of freedom	Mean sum of squares	F ratio	Degree of freedom	Mean sum of squares	F ratio
Between treatments	3	0.4933	26.10*	3	0.8267	36.42*	3	1.01	25.06*
Between days	3	0.3767	19.93*	10	1.1630	51.23*	10	1.073	26.62*
Error	9	0.0189		30	0.0227		30	0.0403	
Total	15	0.8889		43	2.0124		43	2.1233	

*Significant at 5% level

3 and 4. It may be noted that the average panelists' scores decreased gradually with increasing storage period. The appearance and colour of the products were found to fade slowly on processing and storage are the most important factors which account for the greatest proportion of loss of colour. The taste, texture and flavour of the FCSA treated sausage scored less followed by the FCSA + D-lactone treated sample. The unacceptability of the products in the final stages of storage was mainly due to the objectionable flavour and taste exhibited by the animal fat contained in FCSA as Matsuda (personal communication) states that the smell and flavour of the animal fat present in FCSA becomes more pronounced in fish sausage when it is stored for a long period of time. Hence, it is evident that the animal fat contained in FCSA at a higher proportion (67%) has imparted objectionable taste and smell to fish sausage and consequently spoiled the quality of the product.

The control and D-lactone treated samples did not exhibit any objectionable trend with regard to the taste, flavour and texture of the products. However, the average scores for these attributes were also found to decrease gradually as the period of storage increased.

The results of the statistical analysis on the overall acceptability of the sausage samples are portrayed in Table 5. The calculated F ratios were found to be higher than the table values in all the cases. Hence, it

can be safely concluded that the various treatments and the storage period have significant effect on the overall acceptability of the products at 5% level. Moreover, at the room temperature, D-lactone treatment was found to be the best since the mean score (3.15) obtained by the product was the highest followed by the control (3.12), FSCA + D-lactone (2.78) and FCSA (2.46) treatments. But in the case of cooler storage and refrigerator storages, the control treatment was ranked first followed by D-lactone, FCSA + D-lactone and FCSA treatments.

The experimental results show that there is no significant difference between the control and the sausages treated with preservatives with respect to their shelflife. The high temperature processing of fish sausage at 115.6° for 20 min itself is sufficient to preserve the product for enough length of time without the addition of any preservative.

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